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A Basic Treasure Underfoot

Daily, we walk over—and largely ignore—the treasure beneath our feet. This precious soil houses worms, insects, bacteria, and microscopic organisms that live and die within it and enrich it with their bodies.

We should all learn to love, respect, and appreciate the values and limitations of this priceless soil as ancient farmers did. They used many of the same practices to care for the land that we use today—manuring, liming, and crop rotations with legumes.

In the *Odyssey*, Homer told how Odysseus the far-wanderer was recognized at his homecoming first by his dog, who was "lying on a heap of dung with which the thralls were wont to manure the land."

Columella's *Husbandry*, written about 60 A.D., was an agricultural handbook for 15 generations. Some of this Roman's suggestions for soil enrichment and care were good—even in the light of modern agricultural knowledge.

When the pioneers conquered our land, they gave little thought to conserving the soil. There was an almost endless amount of land and many settlers were not interested in permanent agriculture. Thus, much of our soil was blatantly exploited.

Today, we know that our natural resources are not boundless. Every farmer knows that each of the thousands of different kinds of soil requires its own care and skillful use. This, of course, changes from season to season as moisture, temperature, and crops change.

Such simple truths become much more evident when we face the disastrous effects of drought. Again, we are reminded of our urgent needs to conserve.

Our knowledge of soil management is greater than that of our parents, but we must learn more. Agricultural research will help provide this knowledge. More research—thorough research—in managing soil and water is a vital long-range program. Part of this effort must include wider dissemination and application of research results.

We must live in harmony with the soil. Only when we are in harmony, can we till, work, and reap its rich bounty. For soil is a basic treasure to all Americans, no matter where they live.—*M.M.M.*

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COVER: Scientists at Beltsville, Md., have built five laboratory model "agroecosystems" to simulate field conditions for measuring pesticide residues. Discussing test results are plant physiologist M. Leroy Beall, Jr. (left) and soil scientist Ralph G. Nash (0377X321–10). Article begins on page 8.

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Bob S. Bergland, Secretary
U.S. Department of Agriculture

Talcott W. Edminster, Administrator
Agricultural Research Service

Radioactive pesticide is sprayed on bluegrass "lawn" by Mr. Beall. The use of radioactive pesticides enables researchers to better trace the pathways of minute quantities of these chemicals through the contained environment of the agroecosystem (0377X20–24A).

Tracing the fate of pesticides

LABORATORY model "agroecosystems" now permit scientists to simulate field conditions for measuring pesticide residues in soil, plants, water, and air simultaneously.

Inexpensive, versatile, and easy to operate, the agroecosystems are one of the best laboratory efforts yet to monitor the rates and modes of pesticide "disappearance" after applications to crops, says soil scientist Ralph G. Nash, Pesticide Degradation Laboratory (Rm. 105, Bldg. 050, Agricultural Research Center, Beltsville, MD 20705).

Dr. Nash and plant physiologist M. Leroy Beall, Jr., designed and built the agroecosystems to overcome difficul-

Kentucky bluegrass is harvested by Dr. Nash for analysis by gas liquid chromotography and radioactivity detection techniques. At Dr. Nash's left is a soil moisture tensiometer that tells scientists when to trigger the sprinkling system built into each of the five agroecosystems (0377X319–22).

ties in monitoring pesticide residues in the field and to make available to other researchers a simpler and more reliable laboratory model than those previously invented. An obvious advantage over field studies is the ability to run tests year round.

Each of five agroecosystems in operation consists of two sections: a large rectangular glass chamber and an air exhaust manifold with a $\frac{1}{3}$-hp suction fan. By simulating natural air currents, the system exchanges a large volume of air, thus cooling the chambers, preventing moisture condensation, and permitting sufficient air sample volumes to measure minute concentrations of pesticides.

The chambers measure 150 cm long, 115 cm high, and 50 cm wide or about 60x45x20 inches. They are large enough to culture most crop plants to maturity. Researchers can apply a pesticide at different stages of a crop's development, then monitor residues for extended lengths of time.

Currently, Dr. Nash and Mr. Beall are measuring the volatility of different herbicides often used with bluegrass. Small, well-manicured "lawns" of Kentucky bluegrass carpet the 15-cm thick soil layer in each agroecosystem chamber. When soil moisture tensiometers indicate that a lawn needs "rain," built-in nozzles provide a solid cone of sprinkling until the moisture level returns to the maximum desired for the experiment.

Using commonly available materials, the Beltsville scientists built the five agroecosystems for $5,000, not including their labor. "In designing models for this research, we had two choices," explains Dr. Nash. "Either build a specific environment for limited testing or build this type of adjustable system adaptable to most agricultural environments."

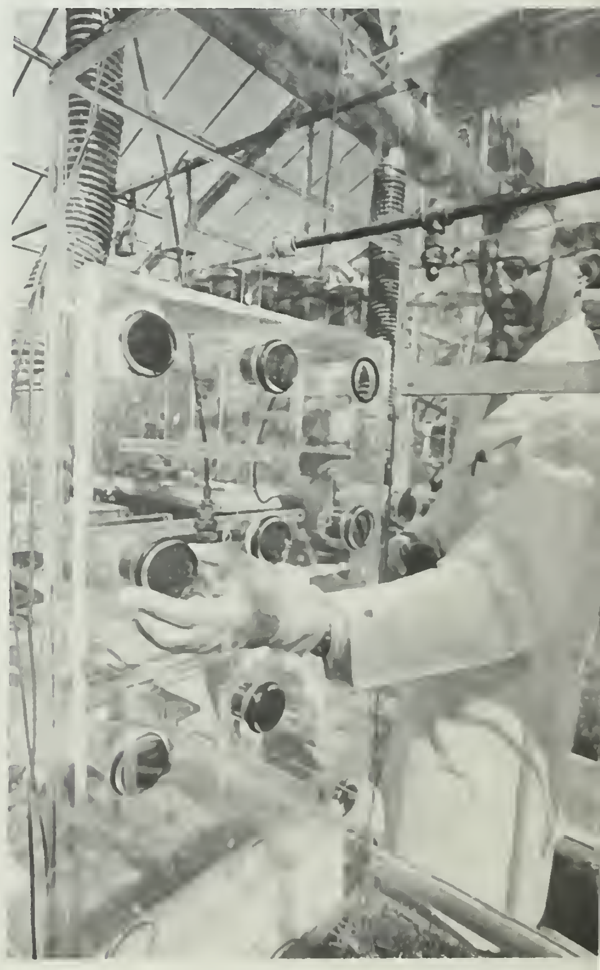
The agroecosystems can provide accurate pesticide measurements from water leached through the soil and from run-off water, and gage persistence in plant tissue and in soil. Automatic humidity and temperature measurements can be taken, and the systems also provide artificial lighting to supplement sunlight or extend daylength.

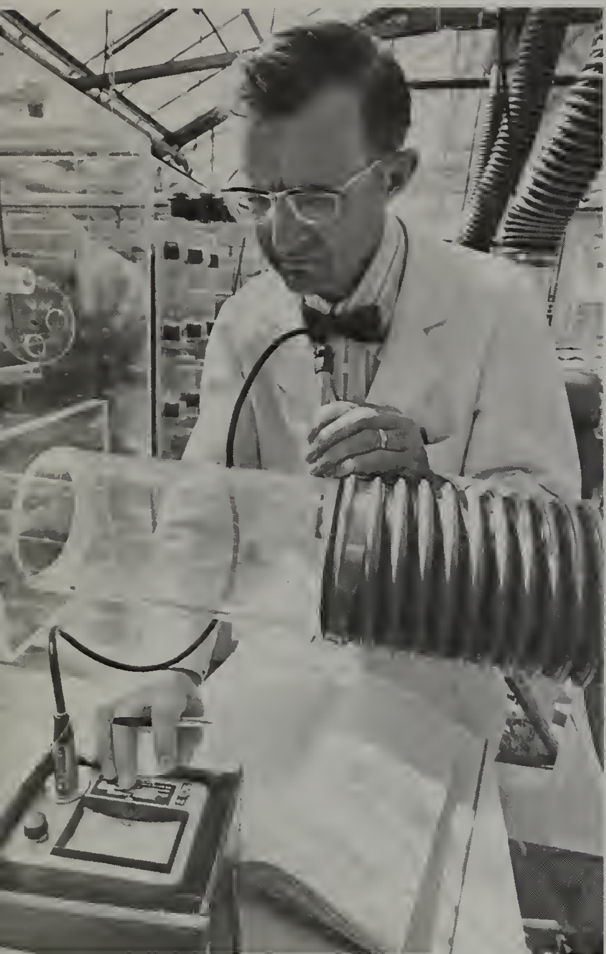
The agroecosystems incorporate a new method of sampling air for pesticide residues. The method consists of drawing air into the glass chamber through 12 holes, 5 cm in diameter, in one end wall and out through 12 identical holes in the opposite wall. Exhaust holes are fitted with polyurethane foam filters which are periodically removed and flushed with organic solvents to extract pesticide residues for analysis. Intake holes have thin foam disks for filtering out insects and dust.

The suction fan responsible for the agroecosystem "wind" is connected to the manifold box by 5-inch (12.8-cm) acrylic tubing and flexible, spring-steel-reinforced hose.

Each chamber is equipped with access panels which ride in felt-lined aluminum channels. When closed, the panels butt against each other, cushioned and sealed by foam weather

Dr. Nash exchanges polyurethane air filters at the air outlet of an agroecosystem chamber. The filters are removed periodically and flushed with organic solvents to extract pesticide residues for analysis (0377X318–20).





Dr. Nash employs an anemometer to measure air flow velocity through the air outlet manifold. This information enables him to calculate the concentration of a pesticide in the air (0377X 318–34).

stripping attached to the end of one panel.

Beltsville scientists were among the first to recognize volatility as a major pathway of dissipation for chlorinated hydrocarbon pesticides such as DDT, chlordane, heptachlor, and toxaphene. Now that the technology for determining the extent of pesticide volatility is being developed, the Beltsville agroecosystems could also have an important role, say Dr. Nash and Mr. Beall.

Their long-term objectives include determining the bioaccumulation of pesticides in terrestrial organisms and hooking up the agroecosystems with other model ecosystems, particularly aquatic models. All of this is consistent with the ultimate goal of the Laboratory—reducing pesticide movement in the environment.—*S.M.B.*

A 3-step cropping sequence

A 40-percent increase in wheat yields and a reduction in saline seep problems and wind and water erosion are the benefits of a three-step—spring wheat-winter wheat-fallow—cropping sequence developed for the Northern Great Plains region.

In 8 years of tests conducted near Culbertson, Mont., the new three-step sequence outyielded the conventional spring wheat-fallow system without any buildup of grassy weeds normally expected of continuous cropping. During the tests, winter wheat yielded nearly 32 bushels per acre following spring wheat and even more when preceded by barley.

Currently, nearly half of the Northern Great Plains cultivated drylands are summer fallowed. These 14 million acres lack protective vegetative covering, leaving them vulnerable to wind and water erosion. Also, much precious precipitation is lost, and the lost water often causes serious saline seep problems. In short, at a time of world food crises the full productive potential of the land is not being tapped.

ARS soil scientists Alfred L. Black and Francis H. Siddoway, Northern Plains Soil & Water Research Center (P.O. Box 1109, Sidney MT 59270), developed the three-step cropping sequence. It was developed while testing whether tall wheatgrass barriers, designed to control wind erosion and to collect and hold snow over winter, could increase soil water recharge enough to support a cropping sequence more intensive than crop-fallow rotations.

Cropping systems within the wheatgrass barriers were evaluated and compared to cropping systems outside of the barriers. The barriers nearly doubled overwinter water storage over that of unprotected lands.

The continuous cropping systems within the barriers used 71 to 80 percent of the precipitation received between crop harvests whereas spring wheat-fallow used only 30 percent. This meant a reduction in saline seep problems as seeps are formed from unused precipitation. The amount of water unused averaged 21.8 inches per year with spring wheat-fallow, and only 3.1 to 4.5 inches for continuous cropping.

Shifting from conventional crop-fallow rotation to the spring wheat-winter wheat-fallow sequence requires better timing of all tillage, seeding, weed control, and harvesting practices. The ARS study indicates that fallowing is not necessary for storing soil water if sound soil and crop management practices now available are applied.—*L.C.Y.*

Above: *Close-up of a new ULV sprayer* **(***1176W1447–14***)**. **Right:** *The sprayer can be pulled by lightweight 15–18 hp tractors, smaller than the one shown, thereby reducing fuel needs and soil compaction* **(***1176W1448–11***)**.

ULV protects apple orchards

ULTRA-LOW-VOLUME (ULV) sprayers for apple orchards may revolutionize the industry—not only for apple growers, but perhaps for other fruit growers as well.

As recently as 10 years ago orchard sprayers applying as much as 400 gallons of spray per acre were in common use. Then low volume sprayers were introduced; these applied only 20 to 40 gallons of a more concentrated spray and used 30 percent less chemical pesticide per acre.

The ULV system applies still less spray and less actual pesticide per acre. ARS-sponsored research in Poland has now improved the techniques and efficiency of this system. The Polish investigators have demonstrated that apple orchards can be protected against fungi and bacteria with as little as 0.7 gallon of spray per acre.

The advantages of this latest technology are numerous. The ULV spray machine is small and less expensive than machines formerly used. It can be pulled by lightweight 15–18 hp tractors instead of the heavy 50–60 hp machines formerly used. This means a saving in fuel as well as less soil compaction.

Another plus: chemicals for ULV application can be premixed at the factory and delivered in manageable 5-gallon containers. This eliminates the need for mixing and washing stations at the orchard and reduces hazards for the operators. The smaller per acre applications of pesticide also result in a lower overall pesticide level in the orchard and reduce likelihood of environmental hazards.

ARS-cooperating scientist Harry L. Keil (Fruit Laboratory, Agricultural Research Center, Beltsville, MD 20705), says these improved techniques for ULV spraying have great promise for U.S. agriculture.

"However," Dr. Keil says, "we need to continually test other compounds—both insecticides and fungicides—as well as other machines in order not to rely on any one system of control. Many insecticides and fungicides are particulate in makeup, and this can cause machine clogging. To prevent clogging, new solvents should be developed. Our goal is constant overall flexibility both in chemicals and in the efficiency of the machinery to apply the chemicals. Fungi, for example, tend to build resistance, sometimes within 3 years, to the chemicals currently available for their control. We need to anticipate such problems as these."

The Polish project was conducted at the Research Institute of Pomology, Skierniewice, under the direction of principal investigator Boleslaw E. Bera. Dr. Bera attended the International Symposium on Low and Ultra Low Volume Ground Application of Pesticides held in 1976 at Beltsville, Md. At that time he explained his work and methods before a group of growers, research specialists, and manufacturers of spray machines and chemicals.—*M.C.G.*

Sunflowers save the day

If winter wheat fails because of drought conditions, it can be followed by sunflowers with good results if early summer rainfall is favorable.

Traditionally, under drought conditions, a failed winter wheat crop has been followed by grain sorghum. Sorghum, however, does not root as deeply as sunflowers and cannot utilize water stored deep in the soil profile.

According to soil scientists Ordie R. Jones and Paul W. Unger (USDA Southwestern Great Plains Research Center, Bushland, TX 79012), sunflower plants are able to extract water from soil depths of 6 to 7 feet.

Grain sorghum seldom reaches water deeper than 4 feet. Thus, while both grain sorghum and sunflowers are drought-tolerant crops and while both crops will use most of the water available to them, sunflowers do have a large volume of soil from which to draw water.

In 1975 at Bushland, dryland grain sorghum with good soil moisture at planting yielded 2,300 pounds per acre compared to a yield of 1,400 pounds for sunflowers.

In 1976, a very dry year, sorghum yielded 500 pounds compared to 340 pounds for sunflowers. A hail storm in late August caused more damage to sorghum than to sunflowers. While the yield per acre in terms of pounds is greater for grain sorghum, the market price for sunflower seeds could make sunflowers the more profitable crop.

The optimum planting date for sunflowers is May 1, but good yields can be expected from planting in early April through mid-May. Planting can be made as late as July 15, but late planting causes a sharp reduction in yield. Dr. Jones points out one disadvantage that sunflower has as compared to grain sorghum: "The crop residue remaining after harvest of sunflowers is inadequate to control wind erosion during many years as was evidenced on February 22, 1977 at Bushland. Although grain sorghum yields were low in 1976, sufficient residue was produced to reduce blowing. On sunflower plots however, chiseling was required to reduce wind erosion."—*B.D.C.*

Not a good mix

Cattlemen have been cautioned against feeding apple pomace and a nonprotein nitrogen (NPN) source to pregnant cattle, and now sheepmen are also being cautioned to avoid this feed.

The problems of weak pasterns and weak and crooked legs that have previously appeared in calves from dams who received an apple pomace-NPN diet have now been found to exist in lambs from ewes fed this diet.

Apple pomace, which contains about 20 percent dry matter, is the leftovers from cidermaking. It may be safely fed to livestock if it is combined with a natural protein supplement such as cottonseed meal or soybean meal. But with increasing prices of protein supplements, producers tend to rely on NPN as the protein nitrogen source—a common practice which gives satisfactory animal performance when used with types of feeds other than apple pomace.

In studies conducted by animal scientist Theron S. Rumsey and chemist Ivan L. Lindahl (Bldg. 200, Beltsville Agricultural Research Center—East, Beltsville, MD 20705), sheep fed a diet of wet apple pomace and urea (an NPN source) gave birth to fewer, less thrifty lambs than ewes fed the same apple pomace with soybean meal as the protein source. Lambs from ewes fed apple pomace-NPN diets also exhibited deformities similar to those in calves. Clues as to why this happens have been the subject of further research by Dr. Rumsey and his colleagues.

Dr. Rumsey found that in cattle, an apple pomace diet tends to cause liquids to pass through the rumen rapidly. This "flushing" of liquids may carry the NPN and/or ammonia with it before the NPN has a chance to be converted into protein by microbes in the rumen. In cattle and sheep, this "flushing" could result in poor utilization of NPN for protein.

Another problem is getting pregnant ewes to eat adequate amounts of wet apple pomace. In a recent trial, pregnant ewes were fed dehydrated apple pomace supplemented with NPN or soybean meal. The ewes ate more, but both groups had an increased number of deformed lambs. Producers are advised not to feed pregnant livestock apple pomace supplemented with NPN.—*M.E.N.*

The Northern Grain Insects Research Laboratory is the only place where researchers rear western corn rootworms routinely. Here, agricultural research technician Gene Miller inspects corn matts that harbor the pests used for study (0976X1144–13).

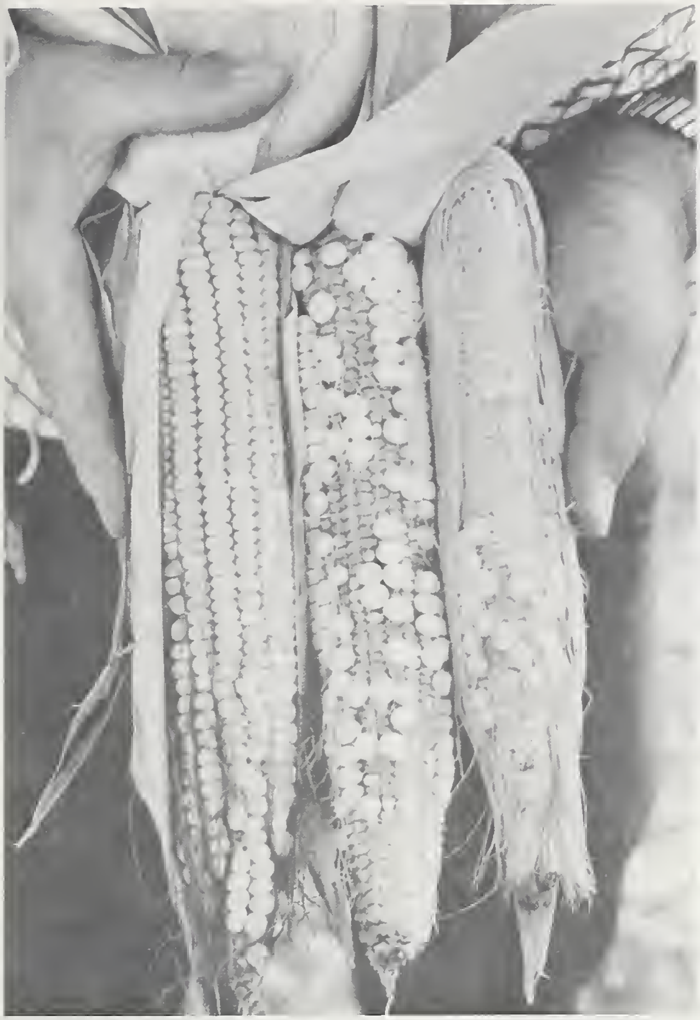
Probing the corn rootwo

THE Nation's corn growers may continue to find that control of the western corn rootworm is an expensive and difficult challenge until scientists learn much more about the pest and develop new crop management systems.

"No one control method seems likely to provide a panacea for this pest problem over the long-term," says plant physiologist Eldean D. Gerloff, who is Director of the Northern Grain Insects Research Laboratory (R.R. 3, Brookings, SD 57006). Corn Belt farmers' net income is reduced by more than $100 million in costs of insecticides each year in addition to over $47 million estimated losses in yields.

Corn rootworms feed as larvae on corn roots, impeding the plants' ability to obtain water and nutrients. As adults, corn rootworm beetles feed on corn ear silks, impeding pollination.

The ARS scientists are exploring pos-



Western corn rootworms can cause severe yield losses as shown by the two ears on right which have been damaged by silk-feeding adults. The ear on left is normal (0976X1143–22).

Above: *Minute size of the western corn rootworm larvae is graphically demonstrated by these specimens photographed with a copper penny (0377X327–20).* **Below:** *Biological laboratory technician Marcia Williams inspects a sex pheromone trap that selectively catches male northern and western corn rootworm beetles (0976X1147–4).*

m's defenses

sibilities for breeding corn that is resistant or tolerant to corn rootworms, finding biological control agents, and devising cultural and other practices to thwart population buildups of the pest.

Just how effectively insecticides alone can control corn rootworms in the future is under question. Years ago, scientists found that strains of insects were developing resistance to one class of insecticide, the chlorinated hydrocarbons. In 1976, entomologist Gerald R. Sutter and a colleague, David Walgenbach at South Dakota State University, Brookings, showed that following repeated applications western corn rootworm populations may also develop resistance to the widely used carbamate insecticide, carbofuran.

Where corn rootworm controls are needed, carbofuran is still an appropriate soil insecticide to use in rotation with other insecticides, says Dr. Sutter. This course may be prudent, he suggests, because it is not presently known whether repeated applications of any or all of the few remaining insecticides approved for corn rootworm may also lead to development of resistant insect strains.

In continuing research, scientists are testing effects of various amounts of currently registered and experimental insecticides on offspring of corn rootworms that are collected from areas where the history of insecticide use is

Agricultural research technician Denise Hanson works at a chamber used to study the effects of relative humidity on corn rootworm egg survival (0976X1142–15).

Insecticides are applied to western corn rootworm adults to determine their tolerance levels (0976X 1154–15).

known. Further, generations of rootworm larvae are being reproduced in the laboratory for testing about three times as fast as they reproduce in the field. By telescoping time, in a sense, the scientists may predict development of corn rootworms' resistance to insecticides in the field.

Resistant strains in the field may develop quickly, some scientists believe, if farmers spray large areas to control adult beetles in late summer as a means of reducing larval populations the next year. Whether the practice actually does reduce larval numbers and should be used on a large scale needs considerably more study, Dr. Gerloff notes. The sprayings may produce alternative problems as beneficial insects—pollinators, predators, and parasites—are killed.

In efforts to enable farmers to use insecticides only when needed, the researchers are refining methods of predicting survival of rootworm eggs. Entomologist Ralph D. Gustin has found that egg hatch is lowest in the top 3 inches of soil where temperature fluctuates greatly. Entomologists James L. Krysan and Terry F. Branson found that the ability of eggs from different corn rootworm strains to absorb water and survive dryness differ from each other throughout embryo development.

ARS scientists from the North Central Soil and Water Research Center at Morris, Minn., are taking part in field studies on the relationships between corn rootworms and soil and crop residues near Madison, S. Dak., on a 100-acre farm leased at nominal expense. The land was purchased for research by a corporation formed by 15 soil and water conservation districts of eastern South Dakota. The research is enhanced by cooperation of the South Dakota Agricultural Experiment Station, the Soil Conservation Service, and the Extension Service.

In eastern South Dakota, where summer droughts often hinder corn production, most farmers use conservation tillage techniques. "The moisture that they save with these techniques can be more effectively used by corn plants if we can develop improved methods of preventing insect damage to the corn root," says Dr. Gerloff. In 1975, corn rootworms reduced corn yields from some fields in the area by an estimated 35 percent.

When corn roots are severely pruned by the insect, the plants may lodge, thereby reducing the efficiency of mechanical harvesting. Geneticist Lowell H. Penny and his colleagues are developing several synthetic breeding populations of corn with extensive root systems that develop rapidly before and during July when corn rootworm larva damage occurs.

"If lines really resistant to the rootworm are to be developed, they will probably be produced through a long-term breeding program," says Dr. Penny. To conduct the program efficiently, a method may have to be worked out for uniformly infesting

corn roots. To provide sufficient numbers of rootworms for controlled infestations in field tests, the scientists also may have to improve lab rearing methods.

Presently, the Northern Grain Insects Research Laboratory is the only place where researchers have developed the expertise to rear western corn rootworms routinely. About three-fourths of the Laboratory's greenhouse space is devoted to rearing rootworms.

Some western corn rootworms are being reared for studies on a sex pheromone or attractant. Biochemist Paul L. Guss is working to isolate and identify the attractant. The sex pheromone from female beetles of the western corn rootworm may become a tool for studies in measuring densities of pest populations. Eventually, the pheromone may save farmers money directly by helping them identify which fields will not need chemical treatments for rootworms.

The rearing of corn rootworms in the laboratory has been hampered by infections of parasitic protozoa called gregarines. These protozoa also commonly infest rootworms in nature, but so far there is no evidence that these protozoa effectively control the rootworms.

Some species of ground beetles may prey on corn rootworms, says entomologist Vernon M. Kirk, but so far he has not noted that such predators are effective in the field. In the laboratory, however, the beetle *Pterostichus chalcites,* ate all of the eggs of western corn rootworms that were provided and also captured active rootworm larvae and adults and devoured them.

The researchers emphasize that they have much to learn about the basic biology of corn rootworms and control measures. Amid the positive and negative research results, the scientists press on. "If the 20 million acres treated for corn rootworms in the United States could be reduced to 1 million acres, a minimal savings of $95 million in chemical controls could be obtained in 1 year," Dr. Gerloft says. —*G.B.H.*

Western corn rootworm beetles feeding on corn silk (0976X1150–14).

The corn root system Dr. Gerloff displays on his right is normal; the root system at his left shows severe damage from corn rootworm—damage that causes farmers to use soil insecticides against this pest on one quarter of the U.S. corn crop (0976X 1142–5).

Cooling with sea air

EMPLOYING SEA AIR rather than mechanically produced refrigeration to cool overseas shipments of some perishable agricultural products could save up to 35 percent on shipping costs.

A system that uses sea air as a cooling medium for dry freight van containers has been developed by agricultural economist William G. Kindya and agricultural engineer William A. Bailey, both of the Agricultural Marketing Research Institute (AMRI, Bldg. 006, Rm. 219, BARC-West, Beltsville, MD 20705).

Perishable fruits and vegetables are normally shipped overseas in refrigerated van containers carried aboard ships. Refrigerated vans are more costly to build and operate and carry less cargo than dry freight van containers.

The cooling system developed by the AMRI researchers can be installed in dry freight van containers. The waterproof, marine-type ventilation system pulls cool sea air across the perishable cargo by means of a thermostatically controlled forced-air system.

The system can be used in the North Atlantic and North Pacific sea lanes during the late fall, winter, and early spring when the sea air is cool enough to keep the cargo at the proper temperature.

The cooling system has been used to ship grapefruit, watermelons, and garlic to European markets and to ship flower bulbs from Holland to the United States. So far, tests indicate that the system keeps produce at or near the proper temperatures.

In a transatlantic test from Florida to France, the cooling system reduced the cost of shipping grapefruit from $2.70 to $1.70 per box, a savings to the shipper of $950 per van container load. This reduction in overseas shipping costs could make our fresh grapefruit more competitive with citrus from other countries by reducing ocean transportation costs. Mr. Kindya estimates that the modified vans could save up to 35 percent on the shipping costs of a number of other agricultural perishables. Additional savings are possible since the new cooling system is less expensive to operate than the system used in refrigerated vans.

Costs for the refrigerated vans themselves are high, about $25,000–$30,000 compared with $7,000–$8,000 for dry freight van containers. Installing the cooling system in the dry freight vans adds only about $1,000 to the cost; if the cooling system were mass produced, the cost would be less.

Installing the cooling system in dry freight vans would also free refrigerated vans for shipping highly perishable cargo requiring lower temperatures. Refrigerated vans must be carried on the upper deck of cargo ships to allow for the dissipation of heat from the mechanical refrigeration units. Since a cargo ship can only carry a limited number of refrigerated vans, the competition for their use is keen. Such things as meat and frozen foods cannot be shipped without the low temperatures generated by these vans. However, certain perishables, such as some fruits and vegetables which need only moderately low temperatures, must compete for space in the refrigerated vans. The new cooling system would help reduce this competition.

"The advantages of this new cooling system have generated wide industry interest," says Philip Breakiron, chief of the AMRI's Transportation and Packaging Laboratory. "We plan to ship other perishable items to determine what the limits are for this type of cooling system. So far, it looks as though the system could benefit a number of products requiring only moderately low temperatures (45°–65° F)."—*M.E.N.*

Dr. Dickinson examines a computer printout summarizing the average PD of active AI bulls which has increased fourfold in the last 10 years (0277X 101–5A).

A I reaches landmark

FOR THE FIRST TIME, bulls being used for artificial insemination (AI) have an average Predicted Difference (PD) for milk yield of 500 pounds. A PD of 500 pounds means that cows sired by these bulls will give an average of 500 pounds more milk in a 305-day lactation than their herdmates of the same breed.

The 500 mark is particularly significant because it represents a fourfold increase in the average PD of AI bulls in the last 10 years. Data on these bulls are summarized by the Animal Improvement Programs Laboratory as part of its research support of the National Cooperative Dairy Herd Improvement Program (NCDHIP). The laboratory is headed by ARS animal scientist Frank N. Dickinson (Room 10–A, Bldg. 263, Beltsville Agricultural Research Center—East, Beltsville, MD 20705).

The NCDHIP, begun in 1905, collects data on all cows in herds enrolled in the program. These data are then summarized by computer to determine such characteristics as the amount of milk and butterfat a particular bull's daughters give. From this information, the bull's genetic merit can be calculated.

Dr. Dickinson says that there are several reasons for AI's contribution to the outstanding genetic progress that has been made in dairy cattle—progress that has far surpassed that of other livestock species.

"For one thing," Dr. Dickinson says, "the uniform, unbiased evaluations on dairy cattle are calculated by the most up-to-date procedures and have been made available to the dairy industry for many years. The data are collected from 32,000 dairy herds in all 50 States and Puerto Rico. The information is summarized in the USDA–DHIA Sire Summary. The summary has been used extensively by dairymen to pick the best bulls to sire their calves.

"Since we conducted research in the late 1960's which showed that the higher a bull's PD, the more money his daughters made, there has been a tremendous demand by dairymen for bulls with high PD milk.

"Finally, AI organizations have placed a lot of emphasis on the use of high PD bulls. Many of these organizations have developed sophisticated programs for selecting and screening young bulls for genetic merit."—*M.E.N.*

Wild sunflowers provide germplasm

THE SUNFLOWER, unlike most of our commercial crops, is a North American native whose wild relatives thrive in fencerows and along roadsides from Texas into Canada.

These wild populations are a warehouse of unexplored characteristics, says ARS plant pathologist David E. Zimmer (206A Waldron Hall, North Dakota University, Fargo ND 58102). They can be utilized in tailor-making varieties containing combinations of characters most suited for superior performance in different growing regions.

This native of our western plains is a relative newcomer as an oilseed crop in North America, although the sunflower is second only to the soybean as a world source of vegetable oil. Sixteenth century explorers carried the sunflower to Spain as an ornamental. Sunflowers subsequently spread east and north in Europe and Asia and later were domesticated.

Sustained commercial production for oil in North America began when high-yielding Russian varieties were introduced in 1966. They are now being replaced by disease-resistant hybrids produced from parent lines jointly released by ARS and North Dakota State University, Fargo. The wild species of the Great Plains probably will contribute to further improvements in cultivated sunflowers.

Dr. Zimmer and graduate research assistant Dale Rehder observed occurrence of sunflower rust in wild sunflowers at some 200 Great Plains locations and collected seed and rust spores. Most field populations contained both rusted and nonrusted plants growing together—an indication that some plants have inherent rust resistance.

In the greenhouse the researchers found that the rusts have one or more common hosts among two annual and five perennial species, so virulence genes are often exchanged. Races 1, 2, and 3 were recovered from annuals and race 1 from perennial species.

The wild annuals are a vast source of rust resistance that can be exploited by plant breeders, Dr. Zimmer concludes. Transfer of rust resistance genes should not be difficult, as wild annuals cross readily with domesticated sunflowers.

Another study shows that wild sunflowers may be sources of genetic diversity in producing commercial hybrids. The study indicates three or four genetically different sources of a trait essential for hybridization, although more than one had only been suggested previously.

The final cross between inbred lines in producing hybrid sunflowers, explains ARS geneticist Gerhardt N. Fick, is between a cytoplasmic male sterile line as the female parent and a fertility restorer line—so the resulting hybrid will produce seed—as the male parent. Three or four different genes for restoring fertility probably exist in wild sunflowers, Dr. Fick found.

With research fellow Juan Dominguez Gimenez, Dr. Fick collected 59 populations of wild annual sunflowers on the Northern Great Plains for crossing with the cytoplasmic male sterile inbred HA 89. All but one of the first-generation plants from these crosses were fertile, an indication that fertility restoration genes are widely distributed in wild annuals. The frequency of these genes in cultivated sunflowers is extremely low.

In seven crosses in which inheritance of fertility restoration was studied, four apparently carried a single dominant gene. Dr. Fick found evidence that three or four genes together may have restored fertility in the other three crosses.

The wild sunflowers in the study cannot be used directly as restorers in commercial production of hybrids, Dr. Fick says. He found, however, that inbred lines with acceptable agronomic characteristics can be selected after one or two backcrosses to cultivated types.

In sum, the wild state flower of Kansas is a valuable resource for maintaining rust resistance and broadening the germplasm base of cultivated sunflowers. Still to be explored is how wild species may contribute resistance to other diseases and tolerance to insect pests.—*W.W.M.*

Importing pig heart valves

EACH YEAR, about 20,000 people in this country undergo heart valve transplants and about 50,000 undergo the operation worldwide.

The valves from pig hearts make excellent replacements for human heart valves. They are durable, resistant to infection, and not readily rejected by the human body. Since 1969, about 25,000 human heart valves have been replaced with the valves from pig hearts.

The valves are taken from several sizes of pigs, with most from pigs of less than 80 pounds. Since pigs in this country are slaughtered at around 200 pounds, the supply of hearts from small pigs is limited. Also, only about 1 valve in 10 is suitable for placing in a human heart, further reducing the supply of valves. Raising pigs strictly for their heart valves would be prohibitively expensive.

Several foreign countries, however, slaughter pigs weighing less than 80 pounds, and the hearts from these pigs can be bought cheaply at slaughter houses. But the hearts have the potential for carrying an exotic disease of swine back to our country. Exotic diseases such as African swine fever, hog cholera, foot-and-mouth disease, and swine vesicular disease could devastate the pork industry of the United States.

To prevent the introduction of an exotic swine disease but still allow the importation of pig hearts, scientists at Plum Island Animal Disease Center have developed an experimental method of inactivating the disease viruses. The method does not damage the heart valves.

The Plum Island scientists, led by veterinarian Jerry S. Walker (P.O. Box 848, Greenport, NY 11944), have found that glutaraldehyde, a substance used to stabilize pig heart valves before their use in surgery, will kill the viruses of foot-and-mouth disease, swine vesicular disease, African swine fever, and hog cholera.—*M.E.N.*

Peppery pesticide

BLACK PEPPER, the pungent dried fruit of the East Indian plant *Piper nigrum L.* long used by man as a condiment, may prove useful as an insecticide to protect stored food products from at least two economic pests.

ARS research chemist Helen C. F. Su, in studies at the Stored-Products Insects Research and Development Laboratory (P.O. Box 5125, Savannah, GA 31403), found that ground black pepper and its alcohol extract are highly toxic to both the rice weevil, *Sitophilus oryzae* (L.), and the cowpea weevil, *Callosobruchus maculatus* (F.).

Treatments with ground black pepper and the extract were generally toxic to rice weevils even at the lowest dosage of 625 p/m on soft winter wheat.

When applied topically, the crude and purified black pepper extracts caused very high mortality. However, mortality was much lower among insects treated with piperine, the major component of black pepper, indicating a minor component may play the bigger role, according to Dr. Su.

Dr. Su believes that black pepper should be a safe, promising source of naturally occurring insecticides. —*V.R.B.*

More sugar from stubble

SUGARCANE can well use a "face-lift" these days. Rejuvenated stubble—2 and 3 years old—could prevent many monetary wrinkles for farmers. With a newly developed planting technique, sugarcane growers can avoid fallow plowing and crop rotation and pocket the profit from better production on less land.

The successful new planting technique also utilizes chemical treatments for maintaining sugarcane yields and stubble.

The object of the research at St. Gabriel, La., was to harvest additional crops from the same sugarcane stubble by controlling root diseases.

ARS plant pathologist Wray Birchfield and agricultural technician Luther R. Brister at the Department of Plant Pathology, Louisiana State University (Room 455, Life Sciences Building, Baton Rouge, LA 70803), planted single stalks of sugarcane on each side of the row of 3-year stubble and achieved double the yield. Most plantings ordinarily use three stalks in the center of new rows.

Stubble deterioration is caused by fungi, bacteria, nematodes, viruses, insects, and weeds. With application of nematicides in combination with fungicides and insecticides and using the single stalk technique, the sugar tonnage was significantly increased in both 2- and 3-year stubbles.

Variety CP 65–137 was used to replant second-year stubble of L 60–25 and third-year stubble of CP 55–30 varieties. The single stalk replant cane was placed in a slot on each side of the row made by tractor-drawn disk hillers. A disk-hiller cultivates the soil by funneling soil into rows. Chemicals in granular form were placed on top of the replanted cane with a hand applicator and covered by the disk-hillers.

The field-plot design was a randomized block with four replications. Three-row plots were used, each 25 feet long, with 10 feet between blocks. The rows were on 6-foot centers.

Sucrose was determined from a six-stalk sample by standard laboratory procedure. Pounds per plot were converted to tons per acre; sugar per ton and sugar per acre were computed.

The chemical teatments were fensulfothion, carbofuran, fenamiphos, ethoprop, potassium azide, and PCNP–ETMT, a mixture of pentachloronitro benzene and 5-ethoxy-3-(trichloromethyl-1,2,4-thiadizole. Also, the PCNB–ETMT was mixed with ethoprop and aldicarb as separate treatments. All materials were used in small, safe, economical doses in granular form. Ethoprop is registered for use by the Environmental Protection Agency. Application has been made for registration of the other chemicals.

Tonnage was not significantly increased by replanting second-year stubble without treatments. The different chemical treatments and combinations increased yields from 2.7 to 8.1 tons per acre. PCNB–ETMT plus ethoprop significantly increased yields to 12.7 tons per acre. All treatments gave higher yields compared with the nontreated check. The stand and marketable stalks were significantly increased by all treatments.

Replanting third-year stubble without treatment doubled the yields. Yield increases of 2.6, 6.88, and 9.53 tons per acre were obtained with carbofuran, ethoprop, and aldicarb, respectively.

The use of this new planting technique along with better pesticide treatments, offers several profitable advantages to the sugarcane farmer. "The rejuvenated stubble should last 2 additional years without replanting," says Dr. Birchfield.—*P.L.G.*

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Know your local tick

A LITTLE-KNOWN TICK, found in the United States only in southern Texas, has been collected from the wild.

It has been studied by ARS entomologist William J. Gladney, biological laboratory technician Charles C. Dawkins (U.S. Livestock Insects Laboratory, P.O. Box 232, Kerrville, TX 78028), and Manning A. Price of Texas A&M University.

The unusual tick, *Amblyomma inornatum*, is not known to transmit diseases; however, several closely related species are known disease vectors of livestock. The knowledge the scientists gained through the study will be useful should the tick become a disease vector.

Amblyomma inornatum, so named because it lacks the typical white "ornamentation" of the other five tick species of the genus *Amblyomma*, infests many species of wildlife as well as dogs, cats, and cattle. The researchers collected the tick from javelina (wild pig), coyote, raccoon, opossum, badger, bobcat, and cottontail rabbit. The tick is also known to infest other wildlife, including the white-tailed deer.

After successfully colonizing the tick in the laboratory, using guinea pigs as hosts, the scientists were able to study its life history and to measure its immature forms, the larvae and nymphs.—*B.D.C.*

Peanut maturity test

A NEW METHOD, both simple and quantitative, has been developed to determine peanut maturity. It is the ratio of kernel weight to hull weight.

The method is based on the changing weight relationship of peanut kernels and hulls during maturation of the pods. Values can be established for green peanut pods or air-dried pods.

The procedure is a product of cooperative research by chemist Harold E. Pattee of ARS, and chemists Johnny C. Wynne, James H. Young, and Fred R. Cox of North Carolina State University (P.O. Box 5906, Raleigh, NC 27607).

Data have been gathered over a 2-year period, and the method correlates very well with the physiological maturity index. Another more difficult method for determining peanut maturity, the arginine maturity index, was more erratic than the proposed method.

The researchers report that the procedure has been applied to two divergent peanut varieties, Florigiant and Florunner, and so should be applicable to all peanut varieties. Further studies are underway to see if this method can be used to indicate the optimum digging date for maximum yield.—*V.R.B.*

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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